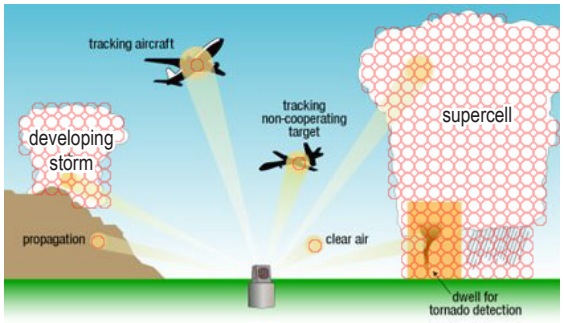
NOAA National Severe Storms Laboratory

Multi-function Phased Array Radar

NSSL has led the effort to repurpose a 1970's vintage U.S. Navy surveillance phased array radar and adapt it for weather. This phased array radar can scan the sky in less than a minute, five to ten times faster than the current operational weather radars. Operators can steer the beam electronically to skip areas of clear air or scan storms vertically to collect more data where the weather is occurring. NSSL's MPAR program is also determining if both aircraft surveillance and weather surveillance can be accomplished by a single radar system.

A multi-function radar

By 2020, more than 350 FAA radars and by 2025, nearly 150 of the nation's Doppler weather radars will need to be either replaced or have their service life extended. Combining the operational requirements of these several radar systems with a single technology solution would result in an estimated savings to the nation of $4.8 billion in acquisition and maintenance costs. The agencies would have access to data from all 350 radars rather than just their own, more than doubling the number of radars available for use by the National Weather Service (NWS) for its weather mission requirements.



The Multi-function Phased Array Radar program (MPAR) is investigating whether a single radar system can perform both aircraft and weather surveillance.

Electronic steering and adaptive scans

The antenna of a phased array radar is a stationary flat or cylindrical panel, unlike the rotating antenna dish on current weather radars. These dishes require 4-5 minutes to mechanically rotate and tilt upwards as they sample the atmosphere around the radar. In contrast, the phased array radar has no moving parts so it can scan the entire sky in less than a minute. Operators can also steer its beams electronically to skip areas of clear air, or scan storms vertically, resulting in more information over areas of severe weather.

The flat-panel of the phased array radar in Norman, Okla., before it was covered with a protective dome.

Tornado warning decisions

In a recent experiment, forecasters from nine NWS offices used rapid-scan PAR data to issue tornado warnings on two tornadic and two non-tornadic archived supercell cases. Verification of the tornadic cases revealed that forecasters using PAR data provided a mean tornado lead-time of 20.1 min, exceeding the current 14 minute national mean tornado lead-times using WSR-88D. Forecasters reported that the higher update frequency of PAR data helped them diagnose and track velocity signatures more efficiently.

Warn-on-Forecast

NOAA's Warn-on Forecast research project, led by NSSL, requires rapidly updating radar data such as data available from phased array radars to create computer forecasts that accurately predict when and where severe weather will occur in the next hour. Every time the Warn-on-Forecast models receive a new phased array radar scan, the forecast models will be updated. Scientists believe these models will eventually be able to predict the probability that severe weather will hit communities up to an hour in advance.

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New software

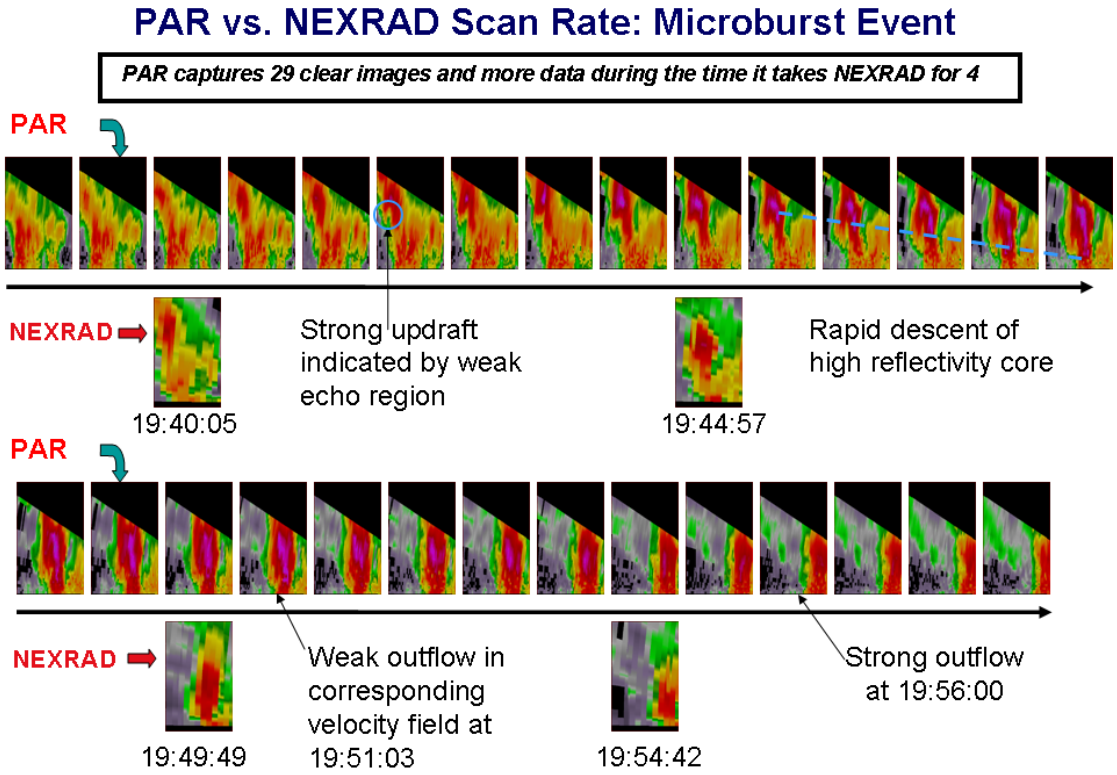
New scanning strategies and techniques are installed and tested each spring and fall to minimize the amount of time MPAR takes to scan a storm without losing data quality. In collaboration with our industry and academic partners, engineers are working to develop a dual polarization demonstrator for MPAR and are testing aircraft tracking techniques.

Research Partnerships

Federal, private, state and academic groups partner to develop MPAR technology. Participants include NOAA NSSL and National Weather Service Radar Operations Center; the Federal Aviation Administration; Lockheed Martin, Raytheon, Northrup Grumman, Ball Aerospace, and Saab Sensis; the Department of Defense; University of Oklahoma's School of Meteorology, School of Electrical and Computer Engineering, and Advanced Radar Research Center; Oklahoma State Regents for Higher Education; Basic Commerce and Industries; Massachusetts Institute of Technology/Lincoln Laboratory, and the Office of the Federal Coordinator for Meteorology.

Benefits of MPAR include:

- Improvements in detection and warning of high-impact, severe weather.
- Tornado warning lead-times extended from the current 14 minutes to 20 minutes, and false alarm rates reduced substantially from the current 75 percent.
- More precise hazardous weather information to improve flight safety and airspace capacity decisions.
- Adaptive vertical scans to detect the embryos of hail before they grow large enough to fall to the ground and cause damage.
- Identify the location of the layer of the atmosphere above 32 degrees to better predict the type of winter precipitation that will fall.
- The capability to track aircraft not responding to air traffic control in U.S. airspace to benefit homeland security and commercial aviation.
- Estimated $4.8 billion in savings to the taxpayer: $1.8 billion with single radars having multi-function capability, $3 billion in life-cycle costs projected over 30 years.



Adaptable phased array radar provides vertical scans of a storm to reveal a forming microburst that went on to produce damaging winds.